Regime-based TRMM and GV Microphysical Studies at MSFC and UAH

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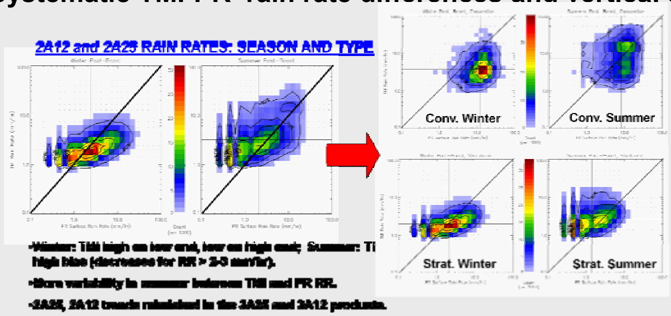
Study

1. Systematic seasonal regime bias in PR and TMI precipitation estimates (local and global)
2. Ground Validation (GV) DSD measurements and applications
   a. DSD retrieval sensitivities as a function of instrument type and meteorological regime
   b. Evaluation of D_{max} assumptions for dual-polarimetric radar scattering calculations

Data and Methods

1. TRMM 1Z99 3-D TMI, PR and LIS statistics composited by TMI-PR rain rate difference.
2. 2D Video Disdrometer (2DVD) DSDs (rain rate ≥ 0.5 mm hr^{-1}, >100 drops), tropical and non-tropical precipitation in N. Alabama.
3. T-matrix/Mueller simulation of C-band dual-pol variables.
4. Parsivel/2DVD DSD retrieval comparisons in N. Alabama (*collaborators: Bringi, Tokay, Thurai*)

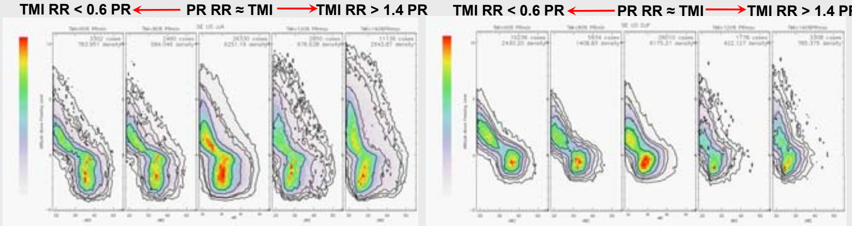
1. Systematic TMI-PR rain rate differences and vertical structure



Southeastern U.S.

JJA — TMI RR < 0.6 PR ⟵ PR RR ≈ TMI ⟶ TMI RR > 1.4 PR

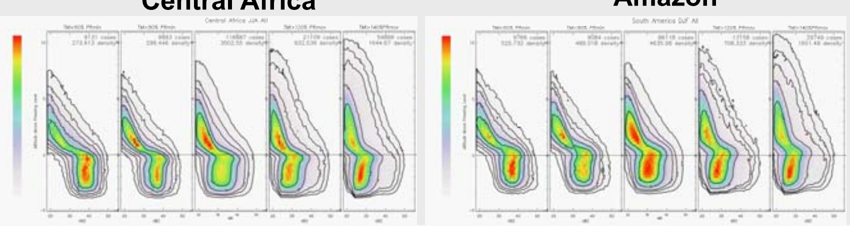
DJF — TMI RR < 0.6 PR ⟵ PR RR ≈ TMI ⟶ TMI RR > 1.4 PR



Common PR CFAD profile behavior between seasons. However factor of 3-4 reversal in seasonal occurrence of associated reflectivity profiles in SE U.S. **This is behavior partially* responsible for driving the observed systematic TMI-PR 2A12-2A25 seasonal biases.**

Central Africa

Amazon



***Common "global" thread:** TMI-PR bias* behavior happens everywhere and is correlated to archetypical vertical profile of reflectivity in the tropics (but not necessarily seasons) but profile behavior is more strongly tied to seasonal regime changes in sub-tropics.

*Complications that need to be examined: PR Attenuation issues in deepest cases (TMI > 1.4 * PR rain rate) TMI vs. PR parallax, beamfilling sample bias- especially in convection.

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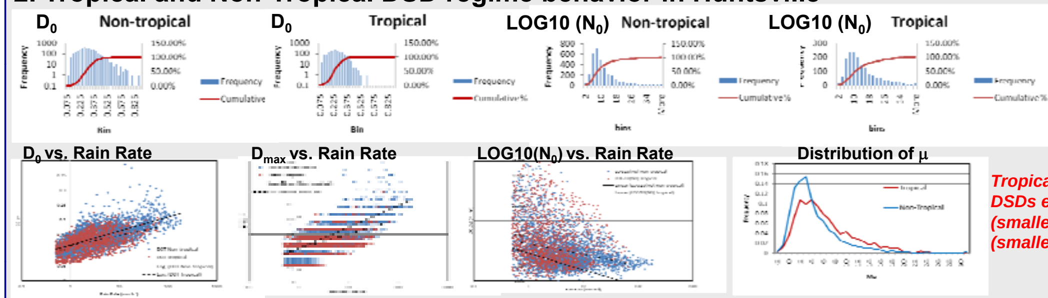
2. Tropical and Non-Tropical DSD regime behavior in Huntsville



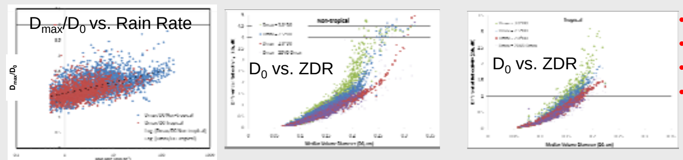
Tropical (Non-Tropical) DSDs exhibit larger (smaller) D0, larger (smaller) N0 and μ

Figure 3. Top row- distributions of D0 and N0 for tropical and non-tropical 2DVD data; **bottom row-** as a function of rain rate.

3. Retrieving DSD with dual-pol radar: Sensitivity of simulated ZDR to D_{max} assumptions

D_{max} must be specified or assumed a priori for modeling of dual-polarimetric variables. This assumption has previously been fixed at values of say, 8 mm, or translated to a function of D_0 by assuming that D_{max}= $C*D_0$, with C = 2.5-3.0 (e.g., Keenan et al., 2001, JAM; Bringi et al., 2006, JMSJ).

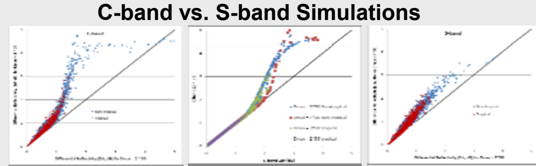
T-matrix simulations of dual-pol variables: What are Impacts of D_{max} assumptions as a $f(D_0)$?



- ***D_{max}/D_0 values similar- typically 2.0-2.5 or smaller.***
- ***D_0 as F(ZDR) dependent on D_{max} via D_{max}/D_0 assumption***
- ***ZDR scatter larger (smaller) for measured (parameterized) D_0.***
- **C-band Mie-resonance enhances error for large drops**

Figure 4: Left: Measured D_0/D_{max} ratio a a function of rain rate and regime. **Center-Right:** Simulated C-band ZDR (dB) for various assumptions of D_{max} as a function of measured median volume diameter (D_0). Left: Non-tropical DSDs, Right: tropical DSDs.

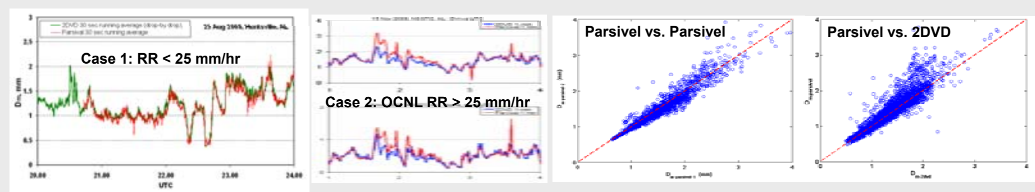
C-band vs. S-band Simulations



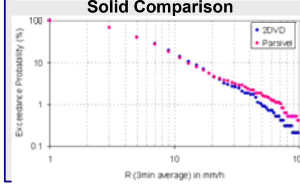
Sensitivity also present at S-band (Fig. 5, right) but not a response to Mie. ***Integration errors in the scattering code also dependent D_{max} assumption***

Figure 5: Left: ZDR at D_{max}/D_0 ratios of 2 and 3 (C-band). **Center**: ZDR for C and S-band. **Right:** Simulated S-band ZDR (dB) for various assumptions of D_{max} /D_0

4. Intercomparison 2D Video and Parsivel DSD measurements: Implications for GV



Solid Comparison — **Differences when D_m > 2 mm?** — **Parsivel vs. Parsivel OK!** — **"Error" in Parsivel enhanced at D_m > 2 mm**



Divergence in Dm and rain rates occur around 25-30 mm/hr (*where D_m beings to exceed 2.0 mm in Parsivel vs. 2DVD*).

Implications for GV network application:

- **Parsivels are robust for rain rates < 25 - 30 mm/hr and D_m < 2.0 mm (fine for validating dual-frequency DPR).**
- **May need to adjust for Parsivel bias using 2DVDs as reference for heavy rain/larger drop occurrences**

Summary of Results:

1. Differences in rain rate between TMI and PR vary systematically with PR Z-profile statistics, whose frequency of occurrence is modified to create seasonal biases in the sub-tropical Southeastern U.S. (and almost certainly elsewhere).
2. Tropical (non-tropical) DSDs in N. Alabama exhibit larger (smaller) D_0, and larger (smaller) N_0 and μ.
3. The formulation process for empirical retrievals of DSD using dual-pol radar is sensitive to D_{max} assumptions used in the scattering model stage.
4. DSD retrievals from Parsivel disdrometers compare favorably to those of the 2DVD unless rain rates exceed 25 mm/hr and D_m exceeds 2 mm (at which point the Parsivels overestimate D_m and rain rate).